

## (12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization  
International Bureau(43) International Publication Date  
23 October 2003 (23.10.2003)

PCT

(10) International Publication Number  
**WO 03/087563 A1**(51) International Patent Classification<sup>7</sup>:**F02G 1/02**

(21) International Application Number:

PCT/FI03/00278

(22) International Filing Date:

11 April 2003 (11.04.2003)

(25) Filing Language:

Finnish

(26) Publication Language:

English

(30) Priority Data:

20020743

18 April 2002 (18.04.2002) FI

(71) Applicant (for all designated States except US): **TIGAN HOLDING OY** [FI/FI]; Bulevardi 2-4 A, FIN-00120 Helsinki (FI).

(72) Inventor; and

(75) Inventor/Applicant (for US only): **TIGANE, Rein** [FI/FI]; Kivivuorenkuja 2 I 81, FIN-01620 Vantaa (FI).(74) Agent: **HEINÄNEN OY**; Annankatu 31-33 C, FIN-00100 Helsinki (FI).

(54) Title: EXTERNAL COMBUSTION ENGINE

(81) Designated States (national): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States (regional): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

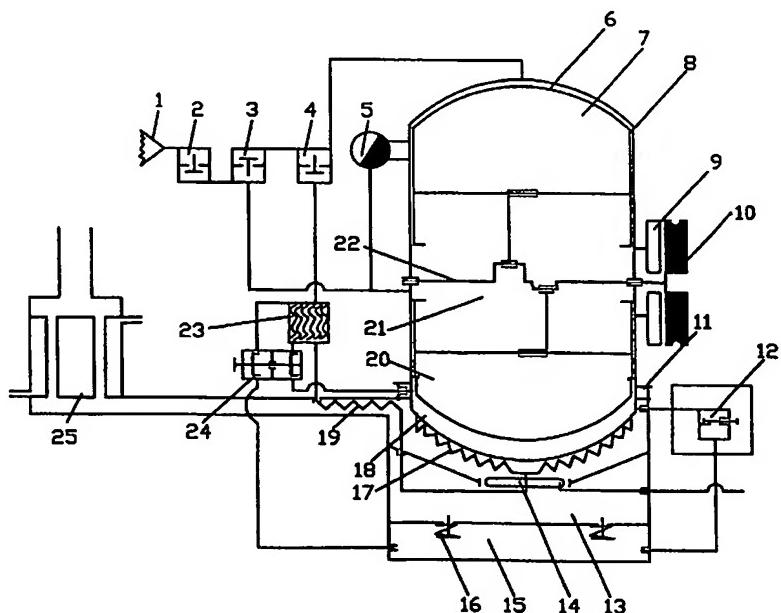
## Declaration under Rule 4.17:

— of inventorship (Rule 4.17(iv)) for US only

## Published:

— with international search report

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

**WO 03/087563 A1**

(57) Abstract: An external combustion engine comprising a body (8), at least one working chamber (18), combustion chamber (13), crankcase (21) and compression chamber (6), at least one working piston (20), compression piston (7) and crank mechanism (22), and a valve gear and a heat exchanger, and wherein the required air is drawn by suction from the air surrounding the engine via valves or equivalent. After the working cycle, the expanded hot air is directed from the working chamber (18) through a valve (12) or (24) past the heater (17) into the combustion chamber (13), to be used as combustion air.

## EXTERNAL COMBUSTION ENGINE

The present invention relates to an external combustion engine as defined in the preamble of claim 1.

- 5 A prior-art external combustion engine is known from US patent specification 4,336,686, which describes a rotating external combustion engine having a radial piston compressor, a continuous combustion chamber and a radial piston expander and means for supplying fuel into the combustion chamber.
- 10 Prior-art machines have the drawback that they are complicated, difficult to service and they need a separate cooler, or the cycle lacks a compression phase.
- 15 The object of the present invention is to achieve a freely breathing external combustion engine that has a simple construction and involves low maintenance costs.
- 20 The external combustion engine of the invention works on the principle that the working gas (air) is changed after each revolution and after the working cycle the expanded hot air is passed from the working chamber through a valve into the combustion chamber, to be used as combustion air. The working air can be preheated using the exhaust gas from the combustion chamber by means of a heat exchanger.
- 25 The characteristic features of the external combustion engine of the invention are presented in detail in the claims below.
- 30 The invention affords several advantages: No cooling is needed as cold air is taken from outside the engine. The engine is easy to seal because it works with a low pressure and possible leakages are compensated for during each revolution.
- 35 In the following, the invention will be described in detail by the aid of an example with reference to the attached drawing, wherein

Fig. 1 presents a diagram of the structure and working principle of the freely breathing external combustion engine of the invention,

Fig. 2 is a graphic representation of the phasing of the pistons of the engine,

5 and

Fig. 3 presents a diagram of the pressure-volume cycles of the engine.

The working principle of the freely breathing heat engine or hot-air engine is as  
10 follows: Outer air is drawn via a filter 1 and an opened valve 2 into the crankcase 21, where it is pre-compressed and drawn by suction via a valve 3 into the compression chamber 6, where it is compressed. (FIG. 3 phase 1).

The compressed air is passed through a regenerator 23 into a preheater 19  
15 and further via a heat exchanger 17 into the working chamber 18. (FIG. 3 phase 2). The hot air performs a working cycle (FIG. 3 phase 3) by pushing the working piston 20 into the upper position. The expanded hot air is removed by the movement of the working piston via the regenerator 23 when valve 24 is open.  
20

The hot air having performed a working cycle is utilized by transferring the residual heat and overpressure into the combustion process. Through an opened valve 24, the hot air is passed via a pressure equalization chamber 15 and pressure compensating valves 16 into the combustion chamber 13 and to  
25 the burner 14.

Depending on the heat requirement of the boiler 25, it is possible to use direct exhaust air connection via valve 12. In this case, the regenerator 23 and valve 24 are turned off and valve 4 is connected directly to the preheater 19.  
30

Valves 12 and 24 are positively controlled. Valves 2, 3 and 4 are also in practice rotating valves at the end of the crankshaft.

Power control and starting are accomplished by means of valve 5 by reducing  
35 the active volume of the compression chamber 6. As the engine requires no cooling equipment, the engine body 8 is a simple tube which houses a compression piston 7, a crank mechanism 22 and a working piston 20. The hot

area of the working chamber 18 is insulated with a heat insulating seal 11. Mounted on the body 8 is the stator 9 of an electric generator, and the rotor-flywheel of the generator is mounted on the end of the crankshaft 22.

- 5 The engine is primarily intended for gaseous or liquid fuels, but with an auxiliary burner it is also possible to use solid fuel.

The engine is intended for the production of electricity in non-built-up areas and for the production of heat and electricity in detached houses. The engine  
10 is also applicable for use as a power source in boats and garden machines.

The engine may preferably have a tubular body containing a crank mechanism and two pistons moving in a phased manner in opposite directions.

- 15 It is obvious to the person skilled in the art that different embodiments of the invention are not limited to the embodiments described above, but that they may be varied within the scope of the claims presented below.

## CLAIMS

1. External combustion engine, comprising a body (8),  
at least one working chamber (18), combustion chamber (13), crankcase (21)  
and compression chamber (6),  
5 at least one working piston (20), compression piston (7) and crank mechanism  
(22), and a valve gear and a heat exchanger,  
wherein the required air is drawn by suction via valves or equivalent from the air  
surrounding the engine, and  
10 wherein the expanded hot air is directed after the working cycle from the  
working chamber (18) through a valve (12) or (24) past the heater (17) into the  
combustion chamber (13), to be used as combustion air,  
characterized in that the air used as working gas is drawn by suction  
through a valve (2) into the crankcase (21), where the air is pre-compressed  
15 and from where the pre-compressed air can be moved through a valve (3) into  
the compression chamber (6).
2. Engine according to claim 1, characterized in that in an isochoric  
phase of the process, the working air is preheated by the exhaust gas from the  
20 combustion chamber (13) by means of the heat exchanger (19).
3. Engine according to claim 1, characterized in that control of power  
by reducing the mean pressure is accomplished by reducing the compression  
volume of the compression chamber (6) by means of a power control and  
25 starting valve (5).
4. Engine according to claim 1, characterized in that the machine has  
a substantially tubular body containing a crank mechanism and two pistons  
moving in a phased manner in opposite directions.  
30
5. Engine according to claim 1, characterized in that the hot air can  
be passed through an opened valve (24) via a pressure equalization chamber  
(15) and pressure compensating valves (16) into the combustion chamber (13)  
and/or to a burner (14).

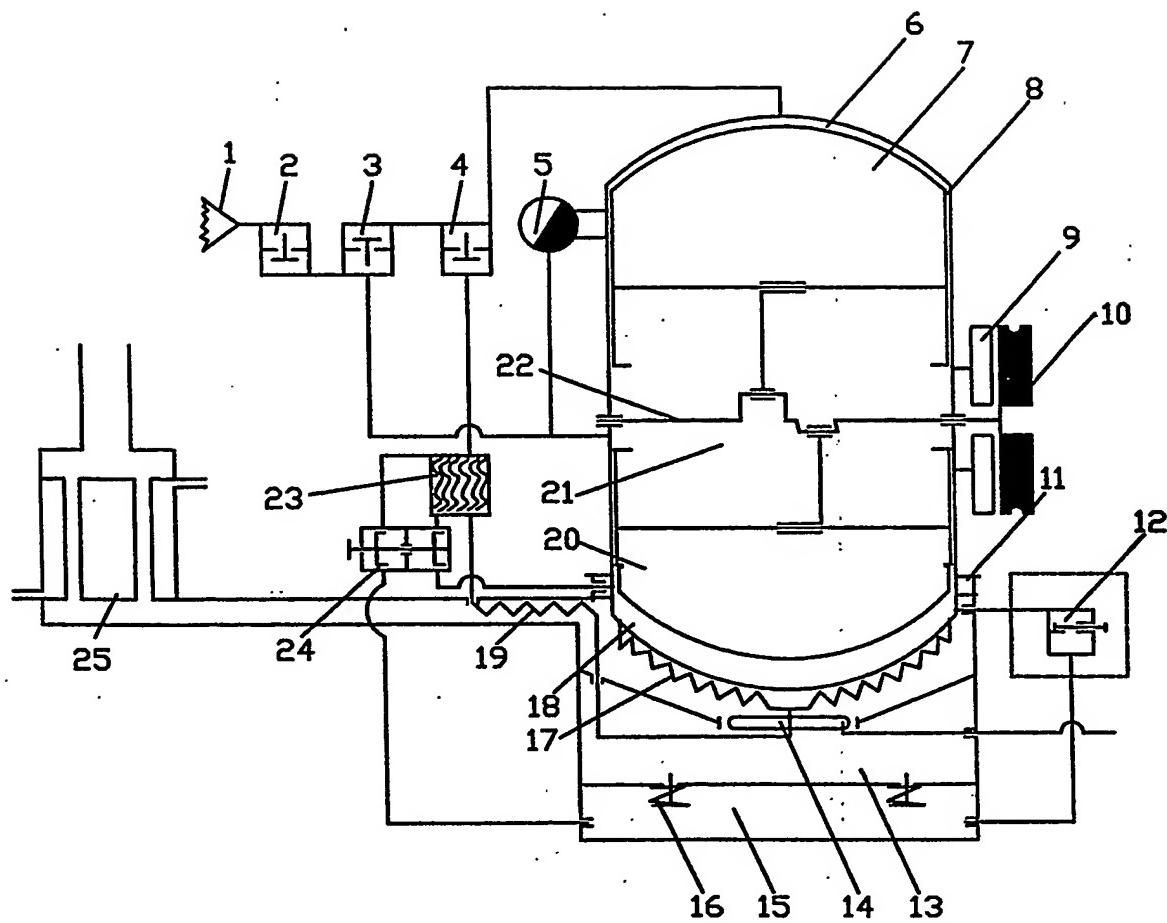


FIG. 1

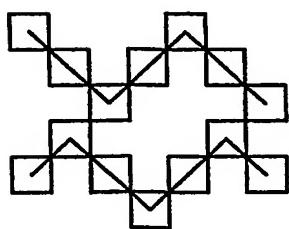


FIG. 2

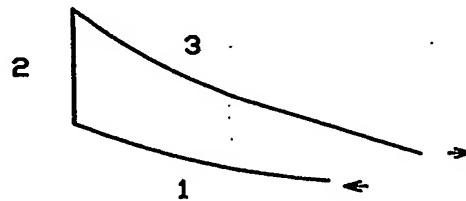


FIG. 3

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI 03/00278

## A. CLASSIFICATION OF SUBJECT MATTER

**IPC7: F02G 1/02**

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

**IPC7: F02G**

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

**SE,DK,FI,NO classes as above**

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

**EPO-INTERNAL, WPI DATA, PAJ**

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 3756022 A (JACQUES O. PRONOVOOST ET AL), 4 Sept 1973 (04.09.73) --	1-5
A	US 4120161 A (REINHOLD C. GEDEIT), 17 October 1978 (17.10.78) --	1-5
A	-B 498882 A (JOHN SUTHERST BRUCE), 13 January 1939 (13.01.39) --	1-5
A	US 4336686 A (KENNETH W. PORTER), 29 June 1982 (29.06.82) -----	1-5

Further documents are listed in the continuation of Box C.  See patent family annex.

\* Special categories of cited documents:

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Date of the actual completion of the international search

26 June 2003

Date of mailing of the international search report

01.-07- 2003

Name and mailing address of the ISA/  
Swedish Patent Office  
Box 5055, S-102 42 STOCKHOLM  
Facsimile No. + 46 8 666 02 86

Authorized officer

Björn Kallstenius/E1s  
Telephone No. + 46 8 782 25 00

## INTERNATIONAL SEARCH REPORT

Information on patent family members

02/06/03

International application No.

PCT/FI 03/00278

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
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